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ABSTRACT

The purpose of this study is to examine multiple influences on twelfth-grade environmental knowledge for a national probability sample of high school students. A longitudinal model was developed and tested incorporating background factors (socioeconomic status and gender) and intervening variables (internal locus of control, level of science class, and informal science education). The variables were placed in the model such that the developmental process of environmental knowledge from tenth-grade to twelfth-grade could be examined. Results revealed that environmental knowledge is the complex result of several diverse variables working collectively. All of the variables in the model made significant contributions (in terms of direct and indirect effects) to environmental knowledge. Of particular interest was the influence of internal locus of control on twelfth-grade environmental knowledge. Aside from the baseline measure, tenth-grade knowledge, internal locus of control had the strongest direct influence on twelfth-grade environmental knowledge. This finding suggests that individuals with an internal locus of control seem to be motivated to obtain more environmental knowledge than those students with an external locus of control. (Author/LZ)

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Locus of Control as a Motivational Determinant of Environmental Knowledge in High School

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ABSTRACT

The purpose of this study was to examine multiple influences on twelfth-grade environmental knowledge for a national probability sample of high school students. A longitudinal model was developed and tested incorporating background factors (socioeconomic status and gender) and intervening variables (internal locus of control, level of science class, and informal science education). The variables were placed in the model such that the developmental process of environmental knowledge from tenth-grade to twelfth-grade could be examined. LISREL estimation of the model yielded an acceptable fit to the data. Results revealed that environmental knowledge is the complex result of several diverse variables working collectively. All of the variables in the model made significant contributions (in terms of direct and indirect effects) to environmental knowledge. Of particular interest was the influence of internal locus of control on twelfth-grade environmental knowledge. Aside from the baseline measure, tenth-grade environmental knowledge, internal locus of control had the strongest direct influence on twelfth-grade environmental knowledge. This finding suggests that individuals with an internal locus of control (i.e., individuals who accept personal responsibility for what happens to them and believe that their behavior is likely to have an impact on the world) seem to be motivated to develop more environmental knowledge than those students with an external locus of control. Locus of control also mediated the effects of background variables and demonstrated a positive influence on the number of science classes taken in high school and participation in informal science activities. Thus, internal locus of control emerged as an important motivational variable in the context of environmental knowledge.

Introduction

Environmental problems are becoming a national concern. In a recent poll, 84% of individuals surveyed reported that they believed that pollution in the country as a whole is serious and getting worse, and 71% agreed that we must protect the environment even if it means higher taxes (Berke, 1990). The environmental dilemmas that citizens will face in the future will be even more complex and hazardous than those which already exist. With environmental problems playing a more prominent role in the lives of citizens, it is important to obtain a better understanding of what students know about the environment and what factors contribute to that knowledge. Surprisingly little research has focused on what students understand about the environment. The research which has been reported has demonstrated an alarmingly low level of environmental knowledge (Arcury & Johnson, 1987; Council on Environmental Quality, 1980; Miller, 1990).

The primary objective of the present study was to utilize longitudinal data to test relations between predictor variables and their casual links to high school environmental knowledge using structural equation modeling techniques. The variables employed in the model have been found to be related to environmental knowledge in previous research. This preliminary conceptual framework of the development of environmental knowledge in the form of a structural equation model will serve as a foundation for future research. The relationship of primary interest will be the influence of the motivational variable - internal locus of control - on twelfth-grade environmental knowledge. Both the direct and indirect effects of internal locus of control on environmental knowledge will be examined.

The model presented in the current study suggests that environmental knowledge is a consequence of unalterable background factors (gender and socioeconomic status) which are mediated through intervening variables (number of science class taken in high school, internal locus of control, and informal science education). The current model incorporates several aspects of an individual's environment and will provide information regarding the complex relationships among variables which contribute to the development of

environmental knowledge in high school students.

Methods

Design and Procedure

A longitudinal design was employed which used data collected from fall 1987 to fall 1989. Student questionnaires were administered each fall and spring. The questionnaires collected data on classes taken, locus of control, and out-of-school activities. Math and science tests were administered each fall; however, environmental questions only appeared on the 1987 and 1989 versions of the science test. Parent telephone interviews were conducted each spring to measure educational attainment, current occupation, and attitudes concerning a variety of topics. The first and third year science achievement tests, developed from the 1985-1986 National Assessment of Educational Progress (NAEP), included several items pertaining to the environment. These items make up the environmental knowledge scales. The items covered environmental issues such as acid rain, the greenhouse effect, and future sources of energy.

Sample

The subjects consisted of a national probability sample made up of approximately 2,900 high school students who are presently participating in the LSAY. The LSAY subjects were selected through the use of a stratified probability sample design. The sample was stratified in two ways: (a) by geographic region (North, South, East, and West) and (b) by degree of urban development (Urban, Suburban, and Rural). Fifty pairs of high schools and middle schools were selected. Once the schools were selected, random samples of approximately 60 students were drawn from each school. Students who dropped out of high school or those who were nonrespondents were not tested. However, when the students were in twelfth-grade all nonrespondents (including drop-outs) were asked to complete a phone interview which was generally an abbreviated version of the written student questionnaire. Response rates over the two year period (fall 1987 to fall 1989) ranged from 77% to 86% for student questionnaires and from 67% to 96% for the science tests . The LSAY codebook (Miller, Suchner,

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Hoffer, Brown, & Pifer, 1991) contains detailed information concerning sample design and implementation.

Data Analysis

Structural equation modeling techniques (LISREL) were used to test a causal model of both the direct and indirect relationships among environmental knowledge and the independent variables.

Structural equation modeling is a statistical procedure which is frequently used to test causal models. This technique uses multiple regression procedures to analyze direct and indirect relationships among independent and dependent variables. Structural equation modeling also allows for the evaluation of the relative effects of each independent variable while controlling for the other factors in the causal model (Hayduk, 1987). In the present study, structural equation modeling was used to measure change in environmental knowledge over time. The model will examine the influence of variables on the growth of environmental knowledge in high school from tenth-grade to twelfth-grade.

Results

Model Results

The over-all goodness of fit of the initial hypothesized model indicates an acceptable fit with the data (Adjusted Goodness of Fit Index = .964, Root Mean Square Residual = .039).[1] These multiple criteria suggest that the likelihood is low that the fit of the model was due to sampling error (Carmines & McIver, 1981; Hayduk, 1987; Reynolds & Walberg, 1991). The total model accounted for approximately 35 percent of the variance in twelfth-grade environmental knowledge.

Significant standardized estimates ($t > 1.96$, $p < .05$) of the full information maximum likelihood analysis are displayed in Figure 1. The arrows extending from one factor to another represent tested effects. The standardized

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[1] The chi-square statistic is an appropriate inferential measure for analyses which use covariance matrixes (Joreskog & Sobom, 1989). A polychoric matrix was used in the present study, so the chi-square statistic is not presented.

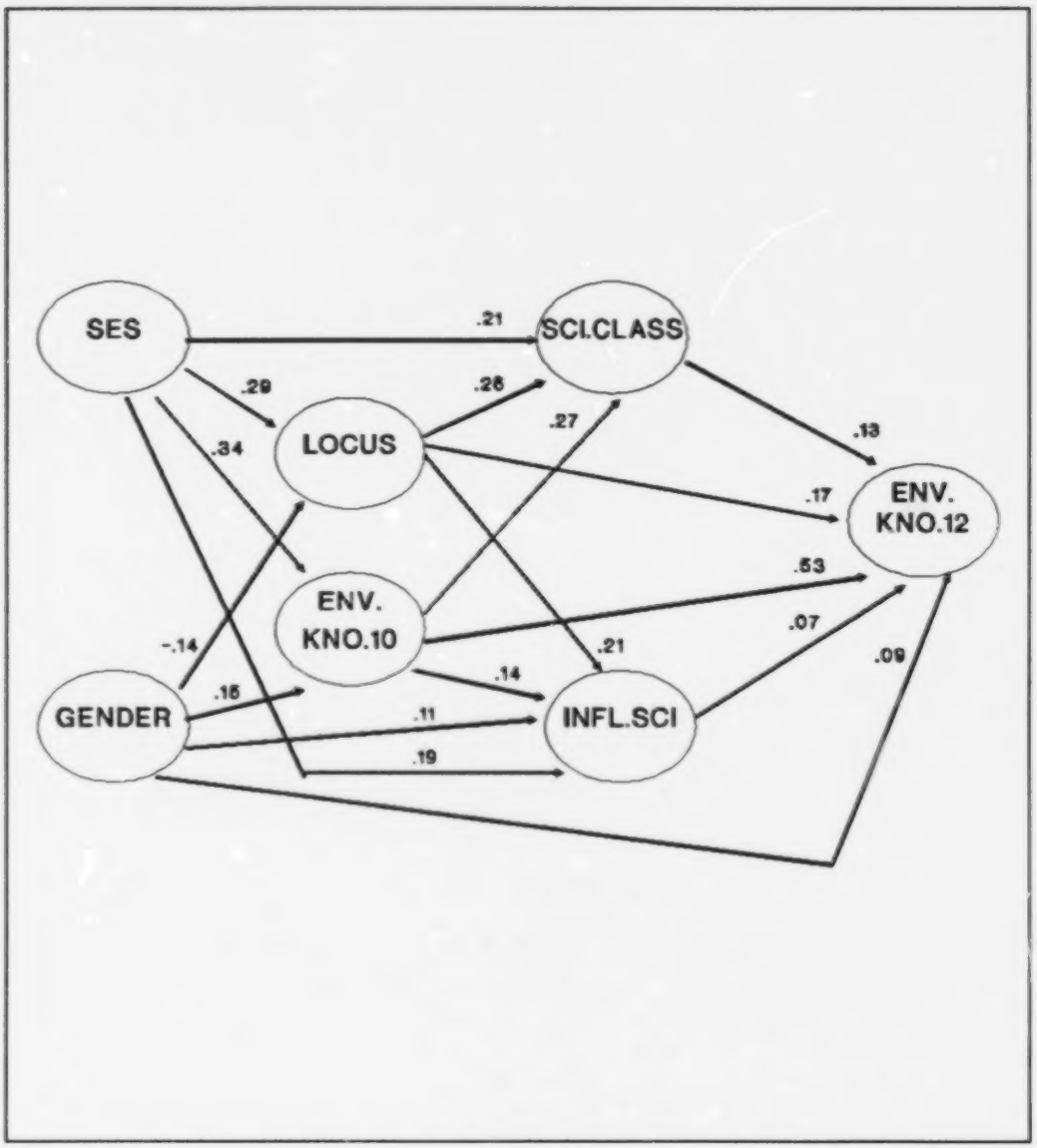

Figure 1. A model of twelfth-grade environmental knowledge. Key. SES = socioeconomic status, GENDER (coded males = 2, females = 1), ENV.KNO.10 = tenth-grade environmental knowledge, LOCUS = internal locus of control, SCI.CLASS = number of science classes taken, INFL.SCI = informal science education, ENV.KNO.12 = twelfth-grade environmental knowledge.

beta coefficients printed on the arrows indicate the direct effect of one factor on another after controlling for all the other variables in the model.

Direct Effects on Twelfth-Grade Environmental Knowledge

As shown in Figure 1, five of the six predictor variables had significant direct effects ($t > 1.96$, $p < .05$) on twelfth-grade environmental knowledge. Socioeconomic status (SES) did not have a significant direct effect on twelfth-grade environmental knowledge. Consequently, the path from SES to twelfth-grade environmental knowledge was dropped from the model. Tenth-grade environmental knowledge had the strongest direct effect ($b = .53$). The positive path coefficient ($b = .09$) between gender and twelfth-grade environmental knowledge indicates that holding constant the other variables in the model, males gained more environmental knowledge than females between tenth-grade and twelfth-grade.

The remaining variables (internal locus of control, number of science classes taken, and informal science education) all had significant direct effects. The best predictor of a relative increase in environmental knowledge is internal locus of control ($b = .17$), suggesting that controlling for the other variables in the model, students with a relative internal locus of control will gain more environmental knowledge than those students with an external locus of control.

Students' enrollment in more lab science classes is another important factor in the development of environmental knowledge. These findings suggest that when all other variables are held constant, students who take more science classes gain more environmental knowledge than students who take less science classes.

Informal science exposure had a weaker direct effect ($b = .07$). This finding indicates that students who participate in more informal science education gain more environmental knowledge than those students who participate less in informal science education.

Together these results suggest that, while controlling for the other

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variables in the model, internal locus of control, formal science education, and informal science education all have a positive influence on environmental knowledge in twelfth-grade.

Indirect Effects on Twelfth-Grade Environmental Knowledge

An indirect effect is a relation between two variables that is mediated by one or more variables. Table 1 summarizes the standardized direct, indirect, and total effects of the predictor variables on twelfth-grade environmental knowledge. Socioeconomic status has the largest indirect effect on twelfth-grade environmental knowledge (b = .28). The SES effect is mediated through tenth-grade environmental knowledge, locus of control, number of science classes taken, and informal science education. This result indicates that SES directly influences previous environmental knowledge, and the mediating variables, but only indirectly influences twelfth-grade environmental knowledge.

Internal locus of control indirectly influenced twelfth-grade environmental knowledge by positively influencing the number of science classes taken and informal science education.

Table 1: Estimates of the Standardized Direct, Indirect, and Total Effects of Predictor Variables on 12th-grade Environmental Knowledge

	Direct	Indirect	Total
Socioeconomic Status	.00	.28	.28
Gender	.09	.06	.15
Tenth-Grade Environmental Knowledge	.53	.04	.57
Locus of Control	.17	.05	.22
Number of Science Classes	.13	.00	.13
Informal Science Exposure	.07	.00	.07

Total Effects

The pattern of the results yielded by the model suggests that twelfth-grade environmental knowledge is the result of several factors. All of the factors had the expected significant direct effects on twelfth-grade environmental knowledge except for SES. SES did not have a direct effect on the final outcome but influenced twelfth-grade environmental knowledge through tenth-grade environmental knowledge and the other mediating variables (locus of control, number of science classes taken, and informal science education). The strength of this influence is demonstrated by the strong total effect of SES on twelfth-grade environmental knowledge ($\underline{b}$ = .28). Only the baseline measure (tenth-grade environmental knowledge) had a larger total effect ($\underline{b}$ = .57). Internal locus of control also had a relatively strong total effect ($\underline{b}$ = .22). Gender (in favor of males) also displayed a significant influence on environmental knowledge. Significant direct and indirect effects of gender produced a moderate total effect ($\underline{b}$ = .15) on twelfth-grade environmental knowledge.

Discussion

The theoretical model tested in this study included several variables which were found to be related to environmental knowledge in previous research as well as the descriptive analyses of the present study. The variables were placed in the model such that the developmental process of environmental knowledge from tenth-grade to twelfth-grade could be examined. Results revealed that environmental knowledge is the complex result of these (and other) variables working collectively. All of the variables made significant contributions to environmental knowledge, and most of the expectations were met.

Aside from the baseline measure, tenth-grade environmental knowledge, internal locus of control had the strongest direct influence on twelfth-grade environmental knowledge. This finding suggests that individuals with an internal locus of control (i.e., individuals who accept personal responsibility for what happens to them and believe that their behavior is likely to have an impact on

the world) seem to be motivated to develop more environmental knowledge than those students with an external locus of control. Locus of control maintained its influence even while controlling for other variables which have proven to have powerful effects on general achievement (e.g., SES and formal education). Thus, an internal locus of control is an important motivational variable in the context of environmental knowledge because it provides students with the expectation that their knowledge and behavior can have a positive bearing on their world.

SES, gender and tenth-grade environmental knowledge all had the hypothesized indirect effects on twelfth-grade environmental knowledge. Thus, the intervening variables (locus of control, number of science classes taken, and informal science education) performed the expected function of mediating the effects of the background factors (SES and gender) and tenth-grade environmental knowledge. This result suggests that the effects of the background factors can be effectively mediated by variables which can be manipulated by parents, teachers, and policy makers (e.g., requiring students to take more science classes).

Locus of control also mediated the effects of SES and gender. This mediating effect of locus of control demonstrates an important link in the development of environmental knowledge. Background factors (SES and gender) influence students' locus of control which, in turn, directly influences twelfth-grade environmental knowledge. Locus of control also had a positive influence on the number of science classes taken and informal science education. This finding indicates that an internal locus of control leads individuals to seek out both formal and informal science educational experiences.

One important aspect of these results is that locus of control may be amenable to change through educational methods. Accordingly, increasing students' internal locus of control may assist educators in overcoming initial obstacles to learning (e.g., low SES). If students believe that events in their lives are due to external factors and beyond their control, they are unlikely to put forth maximum effort to understand the experiences in their lives. Teachers

can personalize environmental problems and show how individuals can make a difference in their community through a simple project on recycling. If students believe their behavior can make a difference, students will be more motivated to thoroughly understand the issues which affect their lives. Teachers should attempt to instill an internal locus of control in students by demonstrating the grass roots nature of several powerful environmental organizations, as well as emphasizing the importance of the personal involvement of individuals in such projects as energy conservation.

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